IN THE MATTER OF
KOREAN PATENT APPLICATION
UNDER SERIAL NO. 9554/1999

I, THE UNDERSIGNED, HEREBY DECLARE :
THAT I AM CONVERSANT WITH BOTH THE KOREAN AND THE ENGLISH LANGUAGES : AND

THAT I AM A COMPETENT TRANSLATOR OF THE APPLICATION PAPERS THE PARTICULARS OF WHICH ARE SET FORTH BELOW :

KOREAN PATENT APPLICATION UNDER SERIAL NO.: 9554/1999

FILED ON: MARCH 20, 1999

IN THE NAME OF: LG ELECTRONICS INC.

FOR: A PLASMA DISPLAY PANEL AND A METHOD FOR COATING PHOSPHOR MATERIAL THEREOF

IN WITNESS WHEREOF, I SET MY HAND HERETO

THIS 28TH DAY OF MARCH, 2003

BY --

KIM, EUN HEE

[Translation]

ABSTRACT OF THE DISCLOSURE

[Abstract]

The present invention relates to a plasma display panel suitable for coating phosphor material uniformly, and a method for coating phosphor material thereof. The plasma display panel comprises a lubricant thin film having a low friction coefficient and coated on a front surface of a lower substrate having barrier ribs, and a phosphor material coated on the surface of the lubricant thin film. According to the present invention, the lubricant thin film having the low friction coefficient is coated before the phosphor material is coated, so that the phosphor material can be uniformly coated even if a height of the barrier rib is high.

[SPECIFICATION]

[Title of the Invention]

A plasma display panel and a method for coating phosphor material thereof

[Brief description of the Drawings]

Figure 1 is a sectional view showing a discharge cell of a general three-electrode alternating current type plasma display panel;

Figure 2 is a flow chart showing a method for coating phosphor material using a screen printing method;

Figures 3A to 3C are sectional views showing a method for coating phosphor material using a screen printing method;

Figure 4 is a flow chart showing a method for coating phosphor material using a sandblast method;

Figure 5 is a flow chart showing a lower substrate structure of a plasma display panel according to one embodiment of the present invention;

Figure 6 is a schematic view of a system for forming a DLN thin film using RF-cosputtering;

Figure 7 is a flow chart showing a method for coating phosphor material using a screen printing method according to one preferred embodiment of the present invention; and

Figures 8A to 8D are sectional views showing a method for coating phosphor material using a screen printing method; and

Figure 9 is a flow chart showing a method for coating phosphor material using a sandblast method according to another embodiment of the present invention.

*** Explanation for the major reference numerals ****

10: upper substrate
12 : lower substrate
14: barrier rib
16 : a pair of sustain electrode
16A : transparent electrode
16B: bus electrode
18 : upper substrate dielectric
20 : passivation film
22 : address electrode
24 : lower substrate dielectric
26: phosphor material

[Detailed description of the invention]

[Object of the invention]

[Field of the invention and background art]

The present invention relates to a plasma display panel, and more particularly, to a plasma display panel and a method for coating phosphor material uniformly thereof.

Recently, a research for a plasma display panel (PDP) having the highest potentiality in a large flat type display market is being greatly performed. The PDP generally uses gas discharge, and visual rays are generated in accordance with that vacuum ultraviolet rays generated at the time of the gas discharge excite phosphor material. By using the visual rays, a certain character or graphic is displayed.

Referring to Figure 1, a structure of a discharge cell of three-electrode alternating current type PDP is illustrated.

The discharge cell of the PDP of Figure 1 is provided with an upper substrate 10 for displaying a screen, and a lower substrate 12 arranged parallel to the upper substrate 10 by a barrier rib 14. The barrier rib 14 forms a discharge space in a cell so as to shield electric and optical interference between cells, and supports the upper substrate10 and the lower substrate 12. A pair of sustain electrodes 16, that is, an injection/sustain electrode and a sustain electrode, are arranged side by side on the upper substrate 10. The

pair of sustain electrode are composed of a transparent electrode 16A and a bus electrode 16B. An address electrode 22 for performing discharge with the pair of sustain electrode 16 is arranged on the lower substrate 12. Also, an lower dielectric 18 for charge accumulation is flatly formed on the upper substrate 10 on which the pair of sustain electrode 16 are arranged. The lower dielectric 18 forms wall charge, maintains discharge by discharge sustain voltage, protects electrode from ion impact at the time of gas discharge, and prevents a diffusion of ions. A passivation film 20 formed at an surface of the lower dielectric protects the dielectric 18 from a sputtering phenomenon of plasma particles and thus prolongs a life span, enhances an emitting efficiency of secondary electron, and reduces discharge characteristic change of fireproof metal due to oxide contamination. As the passivation film, MgO is mainly used. A lower dielectric 24 is formed on the lower substrate 12 on which the address electrode 22 is arranged, and on the lower dielectric 24, phosphor material 26 for emitting visual rays of own colors is coated through the barrier rib 14. The phosphor material 26 is excited by vacuum ultraviolet of short wavelength generated at the time of gas discharge, thereby generating visual rays of red, green, and blue. Also, a mixed gas of He-Ne and Ne-Xe is filled in a discharge space formed in the discharge cell. In this discharge cell, the vacuum ultraviolet rays is selected by address discharge between the address electrode 22 and the sustain electrode 16, and generated by continual sustain discharge between the sustain electrodes 16. The vacuum ultra violet rays excite the phosphor material 26 and emits the visual rays, so that the PDP displays a desired image.

In this PDP, the phosphor material 26 is excited and transited by ultraviolet of 147nm wavelength generated at the time of the plasma discharge, and thus emits the visual rays of the red, green, and blue. In this case, the phosphor material is required uniform coating characteristics besides own material characteristics.

To this end, methods for coating the phosphor material include a screen printing method, a sand blast method, a photolithography method, and an electric melting method. Among these methods, the screen printing method and the sandblast method are the most wisely used, and other methods are being developed.

Figure 2 is a flow chart showing a method for coating phosphor material using a screen printing method.

In the second step, a screen mask for coating red phosphor is located on the lower substrate where the barrier rib is formed, and in the fourth step, the red phosphor is printed and dried to coat the red phosphor material. Then, in the sixth to twelfth steps, green or blue phosphor materials are sequentially coated by the same method with the aforementioned steps. In this case, a method for coating the red, green, or blue phosphor materials using the screen printing method is shown in Figures 3A to 3C.

First, as shown in Figure 3A, a screen mask 28 having a sequentially deposited structure of the address electrode 22, the lower dielectric layer 24, and the barrier rib 14 is positioned on the lower substrate 12. Then, red, green, or blue phosphor material 30 of a paste state is printed on the lower substrate where the screen mask 28 is arranged by using a squeeze 32. Then, the screen mask 28 is removed. As the result, as shown in Figure 3B, the phosphor material 30 is coated on the lower substrate with a similar height to the barrier rib 14. Then, if the lower substrate where the phosphor material 30 of the paste state is dried, an organic solvent included in the phosphor material 30 is evaporated. According to this, as shown in Figure 3C, a volume thereof is decreased, and thus the phosphor material 26 is coated only on surfaces of the lower dielectric layer 24 and the barrier rib 14.

Figure 4 is a flow chart showing a method for coating phosphor material using a sandblast method.

In the step 22, the red phosphor material is printed and dried on the front surface of the lower substrate where the barrier rib is formed. Then, in the step 22, the red phosphor material is light-exposed by using a desired masking and developed, so that the red phosphor material is coated only on a corresponding region with a height of the barrier rib. Then, in the steps 24 to 30, the green and red phosphor materials are sequentially coated on the corresponding region with the height of the barrier rib by the same method. Then, in the step 32, the phosphor material is partially removed by using the sand blast, so that the phosphor material is coated only on the surface of the lower dielectric layer and the barrier rib. Finally, the lower substrate where the phosphor material is coated is molded to complete a phosphor layer.

In the conventional screen printing method or sand blast method, in the case that the height of the barrier rib is 100-200μm, it is possible to coat the phosphor material at the height of the entire barrier ribs. However, in case that a height of the barrier is more than 500 μm, the phosphor material can not be coated uniformly by the conventional coating method. The reason is because the barrier rib where the phosphor material is coated is formed of material of glass or glass-ceramics having a high friction coefficient, and thus the phosphor material can not flow into a deep portion at the time of printing the phosphor material of the paste state.

Accordingly, an object of the present invention is to provide a plasma display panel which can uniformly coat phosphor material on the lower substrate where the barrier rib is formed by using a lubricant thin film having a relatively low friction coefficient, and a method thereof.

[Construction of the present invention]

To achieve the above object, there is provided a plasma display panel (PDP)

including a lubricant thin film formed on a front surface of a lower substrate having barrier ribs, and a phosphor material coated on the surface of the lubricant thin film.

The method for coating phosphor material of a PDP comprises: a step for coating a lubricant thin film having a low friction coefficient and a refractive index above 2.0 on a substrate having barrier ribs, and forming a lubricant thin film; and a step for forming a phosphor material on the lubricant thin film.

Hereinafter, preferred embodiment of the present invention will be explained with reference to Figures 5 to 9.

Figure 5 is a flow chart showing a lower substrate structure of a plasma display panel according to one embodiment of the present invention.

The lower substrate of the PDP shown in Figure 5 comprises a lower substrate 12; an address electrode 22, a lower dielectric layer 24, and a barrier 14 sequentially coated on the lower substrate 12; a lubricant thin film 34 coated on the surfaces of the lower dielectric layer 24 and the barrier rib 14; and a phosphor material layer 26 coated on the lubricant thin film 34. The material of the lubricant thin film 34 according to the present invention has a relatively low friction coefficient lower than 0.06. For example, as the material of the same, there are DLN(Diamond-Like Nano-composite, DLC(Diamond-Like Carbon, MoS_2, Teflon, etc. In addition, the lubricant thin film is capable of uniformly coating the phosphor material 26 and effectively reflecting a back scattering light reflected from the phosphor material layer. Therefore, the lubricant thin film has a refractive index higher than 2.2.

Here, the material-based friction coefficient and refractive index used to the lubricant thin film 34 may be expressed in the following table 1.

Table 1]

Lubricant thin film	DLN	DLC	MoS_2,	Teflon
Friction coefficient	0.03	0.04	0.05	0.05

Refractive index	2.5(max)	2.2	2.4	2.3

As shown in Table 1, the materials used for the lubricant thin film has a friction coefficient of 0.03~0.05 and a refractive index higher than 2.0. Therefore, the materials used for the lubricant thin film 34 according to the present invention have good lubricating characteristics compared to a soda lime glass having a friction coefficient of 0.08~0.09 and the materials of SiO_2 thin film or Si_3N_4 thin film having a friction coefficient of 0.12~0.14. The lubricating thin film 34 having a small friction coefficient has a low resistance characteristic with respect to the flow of the phosphor material, so that the phosphor material 26 is uniformly coated into a deep bottom of the discharge cell interior irrespective of the height of the barrier ribs 14 and the shape of the same such as a stripe type or a lattice shape (for example, rectangular, square and circle, etc.). The lubricant thin film 34 having a large refractive index reflects most of back light of the phosphor material 26 and prevents any interference due to the back light for thereby enhancing a light emitting efficiency of the visual ray. For example, as shown in the following Table 2, the DLN thin film has different refractive indexes based on the kinds of the added metal.

[Table 2]

DLN thin film	W-DLN	Hf-DLN	Zr-DLN	Al-DLN	Nb-DLN
Refractive index	2.2	2.5	2.4	2.2	2.5

The lubricant thin film 34 using the materials having the characteristics of Tables 1 and 2 is grown on a front surface of the lower portion having the barrier ribs 13 by a thickness of 1000Å~10000Å using the high frequency-cosputtering method (RF-cosputtering method), the evaporation method, the IBCD method (Ion-Cluster Bean Deposition method). In addition, a heat treatment may be performed at about 500°C to

remove a certain stress and an inert element contained in the lubricant thin film, and then the phosphor material 26 is coated.

Figure 6 is a schematic view of a system for forming a DLN thin film using RF-cosputtering.

The lower substrate 44 having barrier ribs is fixed by the substrate holder 42,and the interior of the chamber 40 is made to a vacuum state of 10^{-7} Torr. Next, mixed gas of Ar, CH_4, O_2 is inserted into the chamber 40 through the first through third mass flow controllers 45, 46 and 47under a pressure of 3~5mTorr, 50sccm based on a mixture ratio of 100:30:10.When the plasma is formed in a state that the gas is inserted, an acceleration ion of Ar gas collides with the silicon target 48 and the metal target 50 of W, Hf, Zr, Al, Nb, etc. and the carbon target 52 for thereby sputtering each element of the targets. The thusly sputtered elements react with a decompisition ion of CH_4 and O_2 inserted into the chamber, so that a DLN(Diamond-Like Nano-composite) thin film is formed on the front surface of the lower substrate 44. At this time, a high frequency voltage is applied to the silicon target 51 and the carbon target 55 through the high frequency matching units 54 and 60 and the high frequency generators 56 and 62, and a DC(Direct Current) voltage is supplied to the metal target 50 through a DC power supply unit 58. Assuming that the sizes of the targets are 4 inches, the power is 150~300 Watt with respect to the silicon target 48, is 200~300 Watt with respect to the carbon target 52, and is 500~700 Watt with respect to the metal target 50.

The DLN thin film formed by the high frequency-cosputtering method under the above-described conditions has a structure in that a:C-H) network structure and a:Si-O) network structure formed about the metal ion and has a refractive index higher than 2.0 and a very low friction coefficient characteristic of about 0.03 in a few tens of Å in a non-coupled state. Therefore, the DLN thin film has a low resistance characteristic with respect to the flow of the phosphor material, and it is possible to uniformly coat the phosphor material even when the height of the barrier rib is high.

Figure 7 is a flow chart showing a method for coating phosphor material using a

screen printing method according to one preferred embodiment of the present invention.

In the step 40, the lubricant thin film is coated on the front surface of the substrate having the barrier rib. Then, in the step 42, a screen mask for coating red phosphor is located on the lower substrate where the barrier rib is formed, and in the step 44, the red phosphor is printed and dried to coat the red phosphor material. Then, in the steps 46-52, green or blue phosphor materials are sequentially coated by the same method with the aforementioned steps. In this case, a method for coating the red, green, or blue phosphor materials using the screen printing method is shown in Figures 8A to 8C.

First, as shown in Figure 8A, in a state that the address electrode 22, the lower dielectric layer 24, the barrier ribs 14 are sequentially stacked on the lower substrate 12, the lubricant thin film 34 is coated thereon. Next, as shown in Figure 8B, the screen mask 28 is prepared on the lower substrate having the coated lubricant thin film 34, and paste stare red, green and blue phosphor materials 30 are printed on the lower substrate having the screen mask 28 thereon using a squeeze 32 in which a certain pressure is applied after the screen mask 28 is positioned on the lower substrate having the coated lubricant thin film 34. At this time, in the paste state phosphor material 30, since the lubricant thin film 34 has a low resistance characteristic, the phosphor 30 is coated even at a deep portion of the barrier rib 14. Then, as shown in Figure 8C, when the screen mask 28 is removed from the discharge cell filled with the paste state phosphor material 30, it is possible to obtain a state that the discharge cell is coated at a certain height similar to the height of the barrier rib 14. Next, when the paste state phosphor material 30 is dried, the organic solvent contained in the paste state phosphor material is evaporated. Therefore, as shown in Figure 8D, the volume is decreased, and the phosphor material layer 30 uniformly coated on the surface of the lubricant thin film 34 is obtained.

Figure 4 is a flow chart of a method for coating phosphor material using the sand blast method. As shown therein, the method includes Steps ST60 and ST62 for

coating the lubricant thin film on the front surface of the lower substrate having the barrier rib and for printing and drying the red, green and blue phosphor materials, Step 64 for light-exposing and developing the red, green and blue phosphor materials using a desired screen mask, so that the red, green and blue phosphor materials are coated on a corresponding discharge cell at the height of the barrier ribs. Then, in the steps 66 to 72, the green and red phosphor materials are sequentially coated on the corresponding region with the height of the barrier rib by the same method. Then, in the step 74, the phosphor material is partially removed by using the sand blast, so that the phosphor material is coated only on the surface of the lower dielectric layer and the barrier rib. Finally, the lower substrate where the phosphor material is coated is molded to complete a phosphor layer.

[Effect of the invention]

As so far described, in the phosphor material coating method of a PDP according to the present invention, it is possible to coat the phosphor material at a uniform thickness by coating the lubricant thin film having a small friction coefficient before the phosphor material is coated on the lower substrate even if the height of the barrier rib is high. In addition, it is possible to prevent the light interference based on the backward light by reflecting the backward light of the phosphor material using a lubricant thin film having a high refractive index and enhance the light emitting efficiency.

As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiment is not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and

modifications that fall within the meets and bounds of the claims, or equivalence of such meets and bounds are therefore intended to be embraced by the appended claims.

What is claimed is:

1. A plasma display panel (PDP) comprising:

a lubricant thin film layer formed on a front surface of a lower substrate having barrier ribs; and

a phosphor material layer formed on the lubricant thin film layer.

2. The PDP of claim claim 1, wherein a material of said lubricant thin film is selected at least one from the group comprising DLN (diamond-like Nano-composite), DLC(diamond-like Carbon), MoS_2, and Teflon.

3. The PDP of claim 2, wherein said DLN includes one of W, Hf, Zr, Al, and Nb.

4. The PDP of claim 1,wherein a material of the lubricant material has a refractive index of above 2.0.

5. A method for coating phosphor material of a plasma display panel comprising:

a step for coating a lubricant thin film on a substrate having barrier ribs, and forming a lubricant thin film; and

a step for forming a phosphor material on the lubricant thin film.

6. The method of claim 1, further comprising a heat treatment step for removing a certain stress of the lubricant thin film and removing an inert gas contained in the lubricant thin film.